GEOTECHNICAL INVESTIGATION

31st STREET LANDFILL

Springfield, Illinois

JAMES DOUGLAS ANDREWS

ENVIRONMENTAL ENGINEER

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13 September 1974

Introduction

A geotechnical investigation has been made for a proposed sanitary landfill in Springfield, Illinois. The investigation was authorized by the project engineer, Mr. Douglas Andrews, in a telephone conversation of 11 June. This report summarizes the findings and presents conclusions that have been derived from the investigation.

The landfill is to be located on a tract of approximately 40 acres which includes some of the abandoned clay pits that were worked by the Poston Brick & Concrete Products Company on the southeast edge of Springfield. The proposed landfill is to be known as "31st Street Landfill." The owner is Merle Buerkett. Initial purpose of the investigation was to provide basic geotechnical data so that planning for the proposed landfill could proceed with a proper knowledge of the existing geologic conditions and of their effect on costs.

In addition to the field investigation, further information was obtained by searching the available geologic literature. The current exploration consisted of (1) examining the site with special reference to topography as a key to subsurface conditions, (2) making borings to identify and delineate soil and rock units, (3) securing representative samples for inspection and for testing, (4) performing tests on selected samples to determine pertinent engineering properties of geotechnical units which are of significance to the project, (5) taking measurements of groundwater levels, (6) conferring with Mr. Andrews, the project engineer, (7) analyzing the data that were derived from all sources in order to evaluate the pertinent geological and hydrological parameters.

General Geology

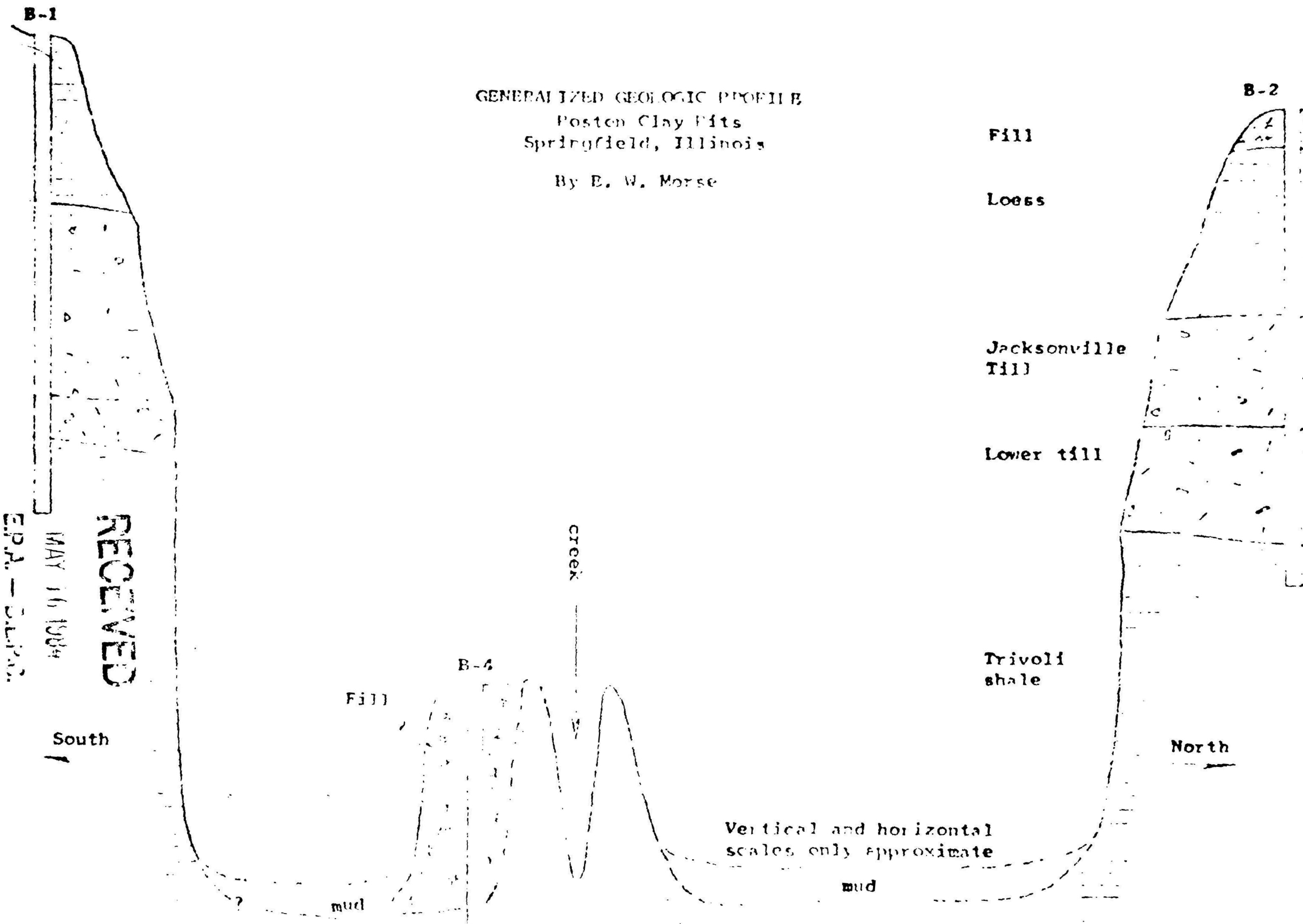
The uppermost bedrock in the vicinity of Springfield is part of the Modesto Formation of the Pennsylvanian Geologic System. The shale which was quarried at the Poston Clay Pits is part of the Trivoli Cyclothem of the Modesto Formation. The Trivoli Cyclothem contains the No. 8 (Chapel) coal, which lies beneath the shale at the clay pits. While the No. 8 coal was extracted from drift mines where it crops out along Sangamon River north of Springfield, generally it was too thin for shaft mining and apparently it was not mined beneath this site.

The No. 6 (Herrin) coal should lie at an elevation of approximately 395 feet. However, the No. 6 coal, which has a thickness of 7 feet as close as Chatham and Taylorville, thins to little or nothing at Springfield and was not mined beneath the tract.

Records indicate that the No. 5 (Springfield) coal was mined beneath the site until 1939 by the Brewerton Coal Corporation and several predecessor companies. The coal was 5.8 feet thick at this site. The Brewerton main shaft was located a short distance north of the tract. The No. 5 coal lies at an elevation of 356 feet, almost 200 feet below the bottom of the clay pits. Mining was of the

GENERALIZED GEOLOGIC PROFILE
Posten Clay Pits
Springfield, Illinois

By E. W. Morse



room-and-pillar type and therefore nearly 50 percent of the coal was left as support pillars. Considering this and the thickness of rock above the mines, it seems unlikely that pollution resulting from mine collapse is a significant risk.

During the Pleistocene Epoch, what is now the site of Springfield was covered by glaciers of the Kansan and Illinoian Glacial Stages. Two tills separated by a sharp contact were formed above the shale. It is presumed that the upper till found in Borings 1 and 2 was deposited by the Jacksonville advance of the Illinoian Stage, the last glacier that advanced over the area. Probably it is the Hulick Member of the Glasford Formation of the Recent Rock Stratigraphic classification. The lower till found in these two borings shows a sharp contrast in composition from the overlying till. The upper unit is a rather typical, strongly-weathered till with a variety of lithologic types, whereas the lower till is composed almost exclusively of shale fragments in a clay matrix. Possibly the lower till is Kansan in age. On the uplands, the till is overlain by approximately 10 feet of loess. This is the accumulation of several episodes of loess deposition since Illinoian glaciers retreated from the area some 150,000 years ago.

<u>Hydrology</u>

<u>Surface Water</u>. The valley of the stream which flows eastward across the tract provided easy accessibility to the shale when the clay pits were opened. The clay pits were dug on either side of the creek, apparently without altering the course of the stream. Im-

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fact, outcrops along the creek suggest that berms of undisturbed shale may have been left for flood protection. There are no surface outlet channels to the ponds occupying the clay pits. Some means of drainage for the ponds will have to be implemented before landfill operations can begin. Furthermore, protection from flooding will have to be provided.

Subsurface Water. Groundwater movement on this tract appears to be minimal. Essentially all of the soil and rock units that were encountered in the borings have very low permeabilities. The only granular material found consisted of cinders used as fill for roadways between the clay pits. However, because of the practice of using cinders as fill, all fill material should be regarded as a possible avenue of groundwater movement. No alluvial sands were found in Borings 3 and 4 near the creek. This is not surprising because the stream is in a relatively youthful stage of development and has a fairly steep gradient.

The shale is generally massive with no granular layers and no significant jointing visible in the outcrops. The floors of the clay pits are layered with fine-grained sediment as can be seen in the pit which has been drained recently. The fact that water levels in the pits are several feet higher than the creek is a good indication that the pits are sealed against leakage by infiltration. The northwest pit has been drained by pumping from a sump. Since the pond was emptied, very little pumping has been required. This indicates that, in spite of the steep walls of the pit, groundwater infiltration into the pit has been minimal. This again is a measure of the

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impermeable nature of the shale and overburden. Because the shale and overburden contain no sand layers, groundwater movement should be toward the creek. Therefore, water quality can most effectively be monitored by sampling water in the stream at points east of the landfill.

The permeability of the lower till, as tested in the laboratory, is 9×10^{-8} cm/second. Permeability of the upper till is estimated from the grain size distribution to be 5×10^{-8}. Either till, the loess or the shale could be adequate for use in building levees and as cover material. Use of the shale for this purpose probably will be limited by difficulty of excavation. It may be possible to excavate a thin, weathered zone at the top of the shale with conventional machinery.

Field Investigation

On 13 August, four borings were made on the proposed landfill site. The project engineer selected boring locations and determined the elevation of ground surface at each location.

Borings were advanced by the hollow auger method in which samples are taken in undisturbed soil below the auger and then recovered through its hollow stem. The boring is drilled to sampling depth with a center plug inserted to prevent soil cuttings from entering the auger. Then the plug is removed and a sample taken either by pushing a 2 inch, thin-walled sampling tube (ASTM: D 1587-69), or by driving a 1 3/8 inch standard split spoon sampler (ASTM: D 1586-67). The number of blows that is required to drive the spoon sampler through a distance of one foot is the Standard Penetration Test value for the soil unit that is being sampled.

To achieve maximum efficiency in the boring program, the engineering geologist was present during boring operations. Samples were removed from the sampler, carefully examined, and identified. This permitted a precision and detail in the identification and interpretation that is not possible with jar samples in the laboratory. In this way, it was practical to make final, complete boring logs in the field and to have professional-level decisions as to depth of borings and type, depth and number of samples. Data obtained by the field investigation are presented in the RECORD OF SUBSURFACE EXPLORATION which is appended to this report.

Laboratory Soil Tests

Tests were made both in the mobile laboratory at the site and in the El Paso laboratory. The physical properties of soil and rock which are pertinent to analysis of this project are not readily measurable. For this reason, comparatively simple tests were selected so that they could be considered in connection with the geological framework to predict the mass behavior of material in the different formations under landfill conditions.

The testing program included (1) a careful examination of each sample to identify the geological unit and to estimate the pertinent engineering properties of the soil (ASTM: D 2488-69), (2) unconfined compression tests on each of the intact, cohesive samples (ASTM: D 2166-66), (3) a natural moisture content determination on part of each sample having a significant clay content (ASTM: D 2216-66), (4) a particle size analysis of representative samples of two of the soil units of particular importance to this project (ASTM: D 422-63), (5) a falling head permeability test on a sample of the lower till. The ASTM test procedures have been altered slightly to adapt to conditions imposed by field testing and to special characteristics of these geologic units. Test results are presented in the SUMMARY OF TEST DATA and in the RECORD OF SUBSURFACE EXPLORATION.

Conclusions

We believe that an environmentally sound landfill operation can be designed for the site of the proposed 31st Street Landfill. The geologic units that were found and tested should provide adequate leachate contaminent and attenuation.

Respectfully submitted,

Edwin W. Morse

Edwin W. Morse

Robert K Morse

Robert K. Morse

SUMMARY OF TEST DATA

Boring No.	B-1	B-2	B-2
Sample No.	S-5	S-7	S-8
Depth (feet)	12-13½	17-18½	19½-21
Geologic Unit	Jacksonville till	Glacial till	Glacial till
Unconfined Compressive Strength (tsf)	2.0		4.8
Natural Moisture Content (%)	22		19
Particle Size Distribution (%)			
Sand	19		16
Silt	69		69
Clay	12		15
Permeability		9×10^{-8}	
Grain Size Classification USDA	Silt Loam		Silt Loam

Cation Exchange

Cation exchange capacity was calculated for three of the units that were encountered in the borings. This was to estimate the ability of the clay minerals to adsorb cations from leachate. The first of these units is the Trivoli Shale, the unit mined by the clay products industry which formerly operated on this site. The cation exchange capacity is calculated from the average clay mineral content as determined by the analyses of several samples taken from this site. The cation exchange capacity of the Trivoli is approximately 11.9 milliequivalents per 100 grams.

The cation exchange capacity was calculated also for the Jacksonville (Hulick) and the Kansan glacial tills. In this case, also, the cation exchange capacity was estimated by using the average clay mineral content of the unit. However, the clay mineral content of a unit as heterogeneous as a glacial till would be poorly defined if it were based on only one or a few samples. Therefore, the values that we have used for tills are based on the average clay mineral content of a large number of samples from each unit. This correlates to a cation exchange capacity in the range of 4.6 to 13.3 milliequivalents per 100 grams for the Kansan till and 3.3 to 10.5 milliequivalents per 100 grams for the Jacksonville till. Because of the difficulty of separating kaolinite from chlorite in the analysis, the more conservative estimate was used, hence the corresponding exchange capacities also would tend to be somewhat conservative.

SOIL CLASSIFICATION

RELATIVE DENSITY

Description	Blows/Foot
Very loose	0 - 5
Loose	5 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	over 50

RELATIVE CONSISTENCY

Description	q_u (tsf)
Very soft	0 - 0.25
Soft	0.25 - 0.50
Firm	0.50 - 1.0
Stiff	1.0 - 2.0
Very stiff	2.0 - 4.0
Hard	over 4.0

PARTICLE SIZES

Gravel	over 2 mm	
Sand	Coarse:	0.6 mm - 2 mm
	Medium:	0.2 mm - 0.6 mm
	Fine	0.06 mm - 0.2 mm
Silt	0.002 mm - 0.06 mm	
Clay	smaller than 0.002 mm	

LAYER THICKNESS

Description	
Thinly laminated	less than 3 mm
Thickly laminated	0.3 - 1.0 cm
Very thinly bedded	1 - 3 cm
Thinly bedded	3 - 10 cm
Medium bedded	10 - 30 cm
Thickly bedded	30 - 100 cm
Very thickly bedded	greater than 1 meter

EXPLANATION OF ABBREVIATIONS AND NOTATIONS

q_u — Unconfined compressive strength expressed in tons per square foot
q_p — Calibrated penetrometer reading expressed in tons per square foot
3ST — 3 inch O.D. thin-walled sampling tube
CA — Continuous flight auger
W — Wash sample
RC — Rock core
WCI — Wet cave in
DCI — Dry cave in
BAR — Before auger removal
AAR — After auger removal
MC — Natural moisture content — weight of water divided by weight of dry soil, expressed as a percent
6-9-11 — Each number represents the number of blows required to drive a standard split barrel sampler six inches
55/4" — Number of blows (55) required to drive a split barrel sampler a certain number of inches (4)
R — Refusal
Effective diameter — D_{10}
Coefficient of uniformity — $C_u = D_{60}/D_{10}$
Coefficient of curvature — $C_z = (D_{30})^3/(D_{10} \times D_{60})$

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NOTES

Unless otherwise designated, samples are taken by driving a 2 inch O.D. standard split barrel sampler (ASTM: D 1586-67) or by pushing a 2 inch O.D. thin-walled sampling tube (ASTM: D 1587-67).

Field classification of samples is based on visual examination of specimens and on results of field tests. Therefore, the relative proportions of grain sizes are based on an estimate of the size of material which controls the engineering characteristics rather than on actual laboratory particle size tests.

Water levels shown on the boring logs may not have stabilized at the last reading. Also, water level readings may not be truly representative of future groundwater tables because of changes in drainage patterns and seasonal variations.

RECORD OF SUBSURFACE EXPLORATION

PROJECT 31st Street Landfill BORING NO. B-1

LOCATION Springfield, Illinois SHEET 1 OF 2

BORING LOCATION SURFACE ELEVATION

BORING METHOD hollow auger STARTED 8/13/74 COMPLETED 8/13/74 DATUM 586.5

ELEV.	DESCRIPTION	DEPTH SCALE FT	SAMPLE NO	SAMPLE BLOWS PER 6	SAMPLE QU TSF	SAMPLE MC %	NOTES
	Brown clayey silt to silty clay. Post Illinoian Loess.						
	Light yellow-brown clayey silt; non-calcareous. Post Illinoian Loess.		1		3.0	22	
	Stiff gray clayey silt; non-calcareous. Post Illinoian Loess.	5	2		1.0	26	
			3		1.0	26	
	Stiff gray and brown mottled silty clay with occasional sand; non-calcareous; sand grains resistant minerals only. Jacksonville Till, Illinoian Glacial Stage.	10	4		1.5	22	
			5		2.0	22	

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GROUNDWATER: Seepage @ BAR 24' AAR 20.5'

After 5 hrs. 10.2'; After hrs. ; After hrs.

DRILLED BY Bob Wulf LOGGED BY Ed Morse

GEOTECHNICAL EXPLORATION COMPANY - U.S. 51 SOUTH - EL PASO, ILLINOIS 61738

RECORD OF SUBSURFACE EXPLORATION

PROJECT 31st Street Landfill

BORING NO. B-1

LOCATION Springfield, Illinois

SHEET 2 OF 2

BORING LOCATION

SURFACE ELEVATION

BORING METHOD hollow auger STARTED 8/13/74 COMPLETED 8/13/74 DATUM 586.5

ELEV.	DESCRIPTION	DEPTH SCALE FT	SAMPLE NO	BLOWS PER 6	QU TSF	MC %	NOTES
	Stiff gray and brown mottled silty clay with occasional sand; non-calcareous; sand grains resistant minerals only. Jacksonville Till, Illinoian Glacial Stage.	15	6		1.7	20	
	Hard dark yellow-brown clayey silt; non-calc; contains brown shale fragments, randomly oriented. Glacial till.	20	7		*4.+	26	* Penetrometer test result (Q_p)
	Gray thinly-bedded shale. Trivoli Cyclothem, Modesto Formation	25	8	50 50/3"		13	
	End of boring @ 25.2'						

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STATE OF ILLINOIS

GROUNDWATER: Seepage @ BAR 24' AAR 20.5'

After 5 hrs. 10.2', After hrs. ; After hrs.

DRILLED BY Bob Wulf LOGGED BY Ed Morse

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RECORD OF SUBSURFACE EXPLORATION

PROJECT 31st Street Landfill BORING NO. B-2

LOCATION Springfield, Illinois SHEET 1 OF 2

BORING LOCATION SURFACE ELEVATION

BORING METHOD hollow auger STARTED 8/13/74 COMPLETED 8/13/74 DATUM 587.5

ELEV	DESCRIPTION	DEPTH SCALE FT	SAMPLE NO.	SAMPLE BLOWS PER 6	SAMPLE QU TSF	SAMPLE MC %	NOTES
	Black cinders and brick fragments. Fill.						
	Gray-brown silty clay; non-calcareous. Loess or colluvium.		1	2 4 5		30	
	Very stiff brown silty clay; non-calcareous. B horizon Loess.	5	2		2.2	26	
	Stiff light brown clayey silt. Post Illinoian Loess.		3		1.3	25	
		10	4		1.5	21	
	Gray and brown silty clay with occasional sand; non-calcareous; sand grains all resistant minerals. Jacksonville Till--Illinoian Glacial Stage.		5		2.0	22	RECEIVED

GROUNDWATER: Seepage @ BAR Dry @ 25' AAR Dry @ 25'

After 2 hrs. 20.5' ; After hrs. ; After hrs.

DRILLED BY Bob Wulf LOGGED BY Ed Morse

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RECORD OF SUBSURFACE EXPLORATION

PROJECT: 31st Street Landfill — BORING NO. B-2

LOCATION: Springfield, Illinois — SHEET 2 OF 2

BORING LOCATION: — SURFACE ELEVATION:

BORING METHOD: hollow auger — STARTED: 8/13/74 — COMPLETED: 8/13/74 — DATUM: 587.5

ELEV.	DESCRIPTION	DEPTH SCALE FT.	SAMPLE NO	BLOWS PER 6"	QU TSF	MC %	NOTES
	Gray and brown silty clay with occasional sand; non-calcareous; sand grains all resistant minerals. Jacksonville Till--Illinoian Glacial Stage.	15	6		2.0	21	
	Hard yellow-brown clayey silt; non-calcareous, contains randomly oriented brown shale fragments. Glacial Till.		7*				* Sealed for permeabi[lity] test.
		20	8		4.8	19	
	Gray shale; Trivoli Cyclothem of Modesto Formation.	25	9	55 45/3"		9	
	End of boring @ 25.2'						

GROUNDWATER: Seepage @ ______ BAR Dry @ 25' AAR Dry @ 25'

After 2 hrs. 20.5'; After ______ hrs. ______; After ______ hrs. ______

DRILLED BY Bob Wulf — LOGGED BY Ed Morse

RECORD OF SUBSURFACE EXPLORATION

PROJECT 31st Street Landfill | BORING NO. B-3

LOCATION Springfield, Illinois | SHEET 1 OF 1

BORING LOCATION ______ | SURFACE ELEVATION ______

BORING METHOD hollow auger STARTED 8/13/74 COMPLETED 8/13/74 DATUM 549.0

ELEV.	DESCRIPTION	DEPTH SCALE FT	SAMPLE NO	SAMPLE BLOWS PER 6	SAMPLE QU TSF	SAMPLE MC %	NOTES
	Black cinders. Fill.		1	12 16 15			
		5	2	4 5 7			
	Randomly oriented gray and brown shale fragments with pockets of cinders. Fill.		3	4 7 11		14	
	Gray shale. Trivoli Cyclothem of Modesto Formation.	10	4			11	
	End of boring @ 10'						

GROUNDWATER: Seepage @ ______ BAR Dry @ 10' AAR Dry @ 10'

After 1.25 hrs. Dry @ 7.5'; After ______ hrs. ______; After ______ hrs. ______

DRILLED BY Bob Wulf LOGGED BY Ed Morse

RECORD OF SUBSURFACE EXPLORATION

PROJECT: 31st Street Landfill — BORING NO. B-4

LOCATION: Springfield, Illinois — SHEET 1 OF 1

BORING LOCATION: — SURFACE ELEVATION:

BORING METHOD: hollow auger — STARTED: 8/13/74 — COMPLETED: 8/13/74 — DATUM: 542.0

ELEV.	DESCRIPTION	DEPTH SCALE FT.	SAMPLE NO	SAMPLE BLOWS PER 6"	SAMPLE QU TSF	SAMPLE MC %	NOTES
	Brown clay with brick fragments and cinders. Fill.		1	3 7 8		18	
		5	2	7 5 8			
	Brown and gray shale fragments with brick fragments. Fill.		3	5 5 7		21	
	Brown and gray, randomly oriented shale fragments. Fill.	10	4			19	RECEIVED
	Brown weathered shale. Trivoli Cyclothem of Modesto Formation.		5	3 8 15	*4+	15	* Q_p, penetrometer test result
	Hard brown & gray shale. **						** Trivoli Cyclothem Modesto Formation
	End of boring @ 13.5'						

GROUNDWATER: Seepage @ ____ BAR Dry @ 13' AAR Dry @ 10'

After ____ hrs. ____ ; After ____ hrs. ____ ; After ____ hrs. ____

DRILLED BY Bob Wulf — LOGGED BY Ed Morse

SKS shaffer·krimmel·silver
& ASSOCIATES, INC CONSULTING ENGINEERS

2900 North Broadway · P.O. Box 2233 · Decatur Illinois 62526 · 217 877 2100

May 14, 1984

Mr. Douglas Andrews
Andrews Environmental Engineering
1320 South Fifth Street
Springfield, Illinois 62703

Re: Buerkett 31st Street
Springfield, Illinois

Dear Mr. Andrews:

We received four (4) bags of disturbed soil from a representative of Andrews Environmental Engineering on April 30, 1984. The samples were identified with field locations and were reportedly obtained at the referenced site.

Laboratory tests were conducted on the samples as directed. The testing program entailed conducting Atterberg limits and grain-size analysis on 2 of the samples. These test results were utilized to estimate the maximum dry density and optimum moisture content expected from the standard Proctor compaction test, ASTM D 698. The moisture content, as received was also determined.

The estimate of the maximum density and optimum moisture content was obtained by utilizing the IDOT Nomographs designed by W.C. Etter and T.K. Liu. The samples were compacted in a Harvard Miniature mold to 90% of the estimated values.

These samples were placed in a triaxial cell for determination of the permeability rate (hydraulic conductivity). The samples were subjected to a confining pressure of 20 psi and back pressured to obtain saturation. A constant head pressure of 15 psi was used during the flow measurement portion of the test. The flow was measured for a period of 8 hrs. or until a constant flow rate was established.

The results of the laboratory testing program are presented on the attached "Soil Classification & Engineering Properties" sheet. The degree of compaction noted is the dry unit weight, as compacted, as a percentage of the maximum estimated from the IDOT Nomographs. The samples were compacted at the optimum moisture content.

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If there are any questions concerning the data presented, please contact us.

Very truly yours,

SHAFFER, KRIMMEL, SILVER & ASSOCIATES, INC.

BY: J. William Coberly
J. William Coberly, Associate

JWC, sal

Attachment: As noted

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2900 N. Broadway • P.O. Box 2233 • Decatur, Illinois 62526 • 217 877 2100

SOIL CLASSIFICATION AND ENGINEERING PROPERTIES

PROJECT: Landfill
Buerkett 31st Street
Springfield, Illinois

JOB NO. I8-42573-6S

DATE: May 14, 1984

	OFF SITE COVER SOURCE NO 1		OFF SITE COVER SOURCE NO 2		
BORING SAMPLE NO'S.	1	2	3	4	
FIELD IDENTIFICATION	Pit "C" South	Pit "C" North	Flyash Pit East	Flyash Pit West	
SOIL PARTICLE SIZES					
GRAVEL;	1		0		
SAND;	21		1		
course	0		0		
medium	5		[illegible]		
fine	16		0		
FINES;	78		99		
silt	45		69		
clay (0.002 mm)	33		30		
PLASTICITY CHARACTERISTICS					
MOISTURE CONTENT	18.3	13.1	10.7	19.7	
LIQUID LIMIT	46		47		
PLASTIC LIMIT	15		19		
PLASTICITY INDEX	31		28		
CLASSIFICATION					
USCS	CL		CL		
PLASTICITY CHARACTERISTICS	Medium to High		Medium to High		
ENGINEERING PROPERTIES *Estimated using IDOT Nomographs					
MAX. DRY DENSITY; pcf *	101.0		108.0		
OPT. MOISTURE CONTENT; % *	20.0		17.4		
DEGREE OF COMPACTION %	90.0	88.0	92.0	89.3	
PERMEABILITY, cm/sec	1.6×10^{-8}	3.4×10^{-8}	1.6×10^{-8}	4.6×10^{-8}	

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